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SWARU

BLUEPRINT FOR THE FUTURE!

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A Decade of Development
November 21st and 22nd, 1979
Toronto, Ontario

Presented by

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SWARU - BLUEPRINT FOR THE FUTURE

Presentation to: Energy From Waste Conference
79 11 21
Toronto

By: Romeo F. Palombella, P. Eng.
Regional Municipality of Hamilton-Wentworth

Mr. Chairman, Ladies & Gentlemen:

I am pleased to accept this opportunity to speak to you today on a subject that has been one of my principal areas of concern for the last two and one-half years, the processing facility called SWARU, or Solid Waste Reduction Unit.

In my portion of this presentation, I will describe the Municipality's role in the waste handling field. I will begin by presenting you with a brief background of Hamilton-Wentworth Region's waste management programme and the supporting role played by SWARU. J. Kennedy will subsequently elaborate upon the energy implications of a mechanical waste processing facility.

Our Region was formed in 1974, and, as part of its scope of duties, assumed the responsibility for the operation of solid waste disposal facilities within its boundaries. Prior to the formation of the Region, each of the six Area Municipalities was responsible for the operation of its own local disposal sites; however in 1974 the Region inherited ten landfill sites and the SWARU incinerator. The Area Municipalities retained the responsibility of refuse collection.

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Previously, in 1968, the City of Hamilton had commissioned a local firm of consulting engineers, Gordon L. Sutin and Associates Limited, to design a 600 ton per day refuse incinerator. This facility was intended as a replacement for the then outdated mass-burning municipal incinerator, and was to assist in alleviating the increasing problem of solid waste disposal in the area.

Construction commenced in 1970 and the plant went into its initial operational phase in the fall of 1972. The original capital cost of the facility was $9 million, which included the land purchase and engineering costs. Present replacement value of this plant, based upon capital improvements and inflation over the last ten years, would be in the order of $20 to $22 million.

Funding for the original project and its ongoing operation was, and still is, obtained from municipal taxes. A one-time grant of $300,000 was provided by the Ontario Ministry of the Environment in 1976, for works to improve the plant's operating efficiency and reduce its environmental impact.

Basic initial plant processes included:
- automated remotely operated vehicle traffic control systems
- raw refuse storage and conveying
- refuse pulverization
- ferrous metal recovery
- semi-suspension burning in water-walled boilers
- electrostatic precipitators for control of air emissions.

End products of the process are salable ferrous scrap and a sterile ash comprising less than 5% of the original volume of refuse.

The SWARU concept incorporated many innovative features for municipal refuse processing, and aroused considerable interest both in North America and overseas. Some of the original novel design features described previously can be more specifically identified as:

- semi-suspension burning
- magnetic separation of ferrous metals before incineration
- conveyor feed system
- shredded refuse storage tank.

As a result of these unique features, numerous initial operating problems, which were new to the realm of refuse processing, understandably arose. This fact subsequently dictated the formulation of original solutions.

In 1974, when the Region assumed responsibility for the SWARU, it was apparent that few of these problems had been adequately resolved.

When the design of SWARU was evolving, five years before the 1973 oil crisis and the subsequent changes in the world's economic climate, energy was cheap and the availability of commonplace raw materials was apparently limitless. The primary purpose of the new plant was to efficiently reduce solid waste

to a fraction of its original volume for ease of handling and landfilling, and do so in an environmentally acceptable fashion, without the air pollution problems previously associated with municipal incinerators.

With this prerequisite in mind, water walled boilers were specified in the plant design to reduce the temperature of the exhaust gases to approximately 550°F, thereby permitting the use of electrostatic precipitators having a high degree of efficiency, for proper emission control.

The potential future use of generated steam, actually a by-product of the original process, as an inexpensive energy source was a secondary consideration. Therefore, the design of the plant incorporated roof-mounted air-cooled steam condensers, which discharged waste heat to the atmosphere. Approximately 25% of the steam production is used for plant heating and driving process turbines. The overall operation will be covered in more detail by J. Kennedy later in this presentation.

In 1976 the Region solicited proposals from private industry for the development and operation of a comprehensive waste management system. The Canadian firm of Tricil Limited was awarded a ten-year full service contract for such a system in 1978. Their proposal consisted of:

- the operation of SWARU
- the construction and operation of three compaction transfer stations and bulk haul, by means of 75 cubic yard capacity tractor-trailer units, to a new landfill site, which will

also be operated by the Tricil firm.

The new waste management system, slated for full operation by mid 1980, is designed to serve a Regional population of 408,000 people generating 600,000 tons of refuse per year. This population is distributed over an area of 440 square miles, with the greatest concentration, 312,000 people, located in the Area Municipality of Hamilton. Final approval of the proposed landfill operation is pending, while the Ministry of the Environment reviews the recommendations of the Environmental Assessment Board.

The Region's novel approach to waste disposal, utilizing the contractual services of a private firm, was developed in order to achieve the mose efficient waste management system possible. Entering into such a contract meant that the Region was able to employ a single contractor to undertake the responsibility for all phases of its waste disposal facilities, including the SWARU plant. The Region was satisfied that it had adopted an acceptable system at the lowest possible cost. We received a further commitment from Tricil Limited to operate SWARU at a guaranteed annual process level of at least 120,000 tons, at a fixed base cost plus an annual inflation index factor. A bonus payment will be awarded to Tricil if the annual plant process rate exceeds 150,000 tons or a financial penalty may be levied by the Region if the annual process rate is under 120,000 tons.

Tricil Limited was also committed to initially implementing significant improvements at SWARU, and subsequently to the establishment of measures for resource recovery from the refuse routed through transfer stations. The latter requirement is to be implemented within the first five years of their contract.

The selection of a firm such as Tricil Limited was based upon a practical need to take advantage of the technical expertise and support staff available in this particular company and its parent firms, CIL and Trimac Limited, which are based nation wide in Canada. This permits the utilization of expert staff, experienced in the modern methods of waste management and process plant operation, without the initial financial outlay and overhead expenses otherwise required for the Region to establish a permanent technical support group.

When Tricil Limited took over the operation of SWARU in February 1978, a programme to remedy certain outstanding process inadequacies, in co-operation with the Region, had been defined in the contract documents. These problems have been resolved, for the most part, and Tricil Limited has pursued a course of refined modifications and capital improvements over the last eighteeen months, permitting SWARU to achieve a level of consistent and reliable performance.

As indicated in Figures 1 & 2, SWARU has recently reached daily processing peaks of nearly 600 tons, its original design capacity, and an average monthly processing rate of up to 423 tons per day, considered a reasonable quantity. This latter average figure has been improving consistently for the last year and is expected to surpass the 550 tons per day level within the next twelve months.

Figure 3 defines the annual processing record of SWARU from 1973 to the present. It is apparent that a performance level of 50,000 tons per year improved only after extensive research and modifications were carried out by our contractor.

Total annual operating costs and costs per unit ton processed are graphically represented in Figure 4. It should be noted that the high costs and low productivity in 1978 are representative of the fact that substantial improvements were implemented at SWARU during this year, with resultant frequent and lengthy process interruptions. The year 1979 can be also construed as being a transition year in part, while 1980 will represent the first calendar year of normal plant operation under the Tricil contract. The first process performance year of the SWARU agreement is in fact in effect from 79 07 15 to 80 07 15.

An overview of the approximate projected costs associated with the new waste management system are noted herein:

Capital Costs

i)	Land acquisition for:	
	1 landfill site (550 acres)	$ 2.4 million
	3 transfer stations	
ii)	Landfill site preparation	1.5 million
iii)	Construction of 3 transfer stations (by Tricil Limited)	6 million
iv)	Services	1 million
	TOTAL	$ 10.9 million

Annual Operating Costs: 1981

i)	Annual debenture of capital costs	
	Total System	$ 2.5 million
ii)	Annual Total service contract sum	6 million
	Total operating costs	$ 8.5 million
iii)	Annual gross cost per capita	$20 - $22
iv)	Gross cost per ton	$15 - $20

Actual Operating costs iii) and iv) to be determined after weigh scale data is available following first year of contract period.

I should point out that the delivery of suitable refuse is a variable factor in the operation of SWARU and affects its reliability as a consistent energy supplier. The basic design parameters and equipment incorporated in this facility require that certain types of refuse be eliminated from the waste process stream. Items such as carpets, furniture, appliances, and wire bales are capable of causing serious damage or blockage of the plant's equipment. In an effort to minimize the possibility of damage or process slowdowns, the Region enacted a By-law in 1978 to prohibit the introduction of these materials in refuse delivered to SWARU. This has been achieved with the co-operation of the Area Municipalities which deploy auxiliary collection vehicles to pick up unacceptable classes of refuse, or restrict the collection of oversized discards to specific days of the year.

We have also been successful in obtaining selective routing of collection vehicles from sources generating wastes that are known to be suitable for the SWARU operation. Our major local industries and institutions such as Stelco, Dofasco, and McMaster University have been very helpful in this regard.

However, we must also consider that the characteristics and available quantities of municipal refuse change constantly. The variability of refuse production in the Region influences the through-put efficiency of the plant and its consistent energy generating potential if full delivery requirements are not met.

Daily peak solid waste quantities may be up to 30% greater in the spring and fall than in mid-summer and mid-winter, as a result of seasonal changes in personal and household activities, but this is a factor over which the Region has no control. This is a point to be considered when evaluating a facility's average annual performance.

In summary of this initial portion of our presentation, I trust that I have provided a good introductory description of a refuse processing plant which converts municipal garbage to a useful form of energy, high-pressure steam.

SWARU is not in the planning stage, nor is it operating for experimental or demonstration purposes, although improvements are always being considered and there is a great deal of new knowledge forthcoming from the ongoing developments at this sort of facility. SWARU is operating now and operates reliably. The Region expects, and depends upon, SWARU to handle its daily waste disposal requirements in order to conserve rapidly diminishing landfill space.

We have also awakened to the fact that energy will no longer be as cheap or abundant as it has been in the past; in fact there may arise critical periods when conventional forms of energy will not be available. Processing facilities such as SWARU would have the capability to derive useful energy from an otherwise waste material, and to do so in an economical manner. This potential may not be sufficient to fully compensate for other energy shortages, however, it could certainly temper or postpone such an eventuality.

I can sincerely state that this plant is a functional facility operating to satisfy present and future needs.

Many of us are aware that a number of recent developments in the field of waste processing have been touted as the solution to the solid waste and energy challenge.

Regardless of the publicity being given to the various approaches to solid waste management and waste recovery systems, most or all such facilities in North America are in the conceptual, experimental, or research stage. Certain similar projects in the United States have been abandoned because of lack of adequate technology or funds, but we in Hamilton-Wentworth have persevered in our efforts, at no mean cost.

The Hamilton-Wentworth Region and Tricil Limited are proud to be pioneers in the new era of waste management and energy recovery and we will continue to dedicate our efforts to this developing technology.

I now turn the platform over to Joe Kennedy who will describe the role of his firm in the SWARU project.

Thank you for your attention.

S.W.A.R.U. PEAK DAILY DELIVERY RATES 1978-1979

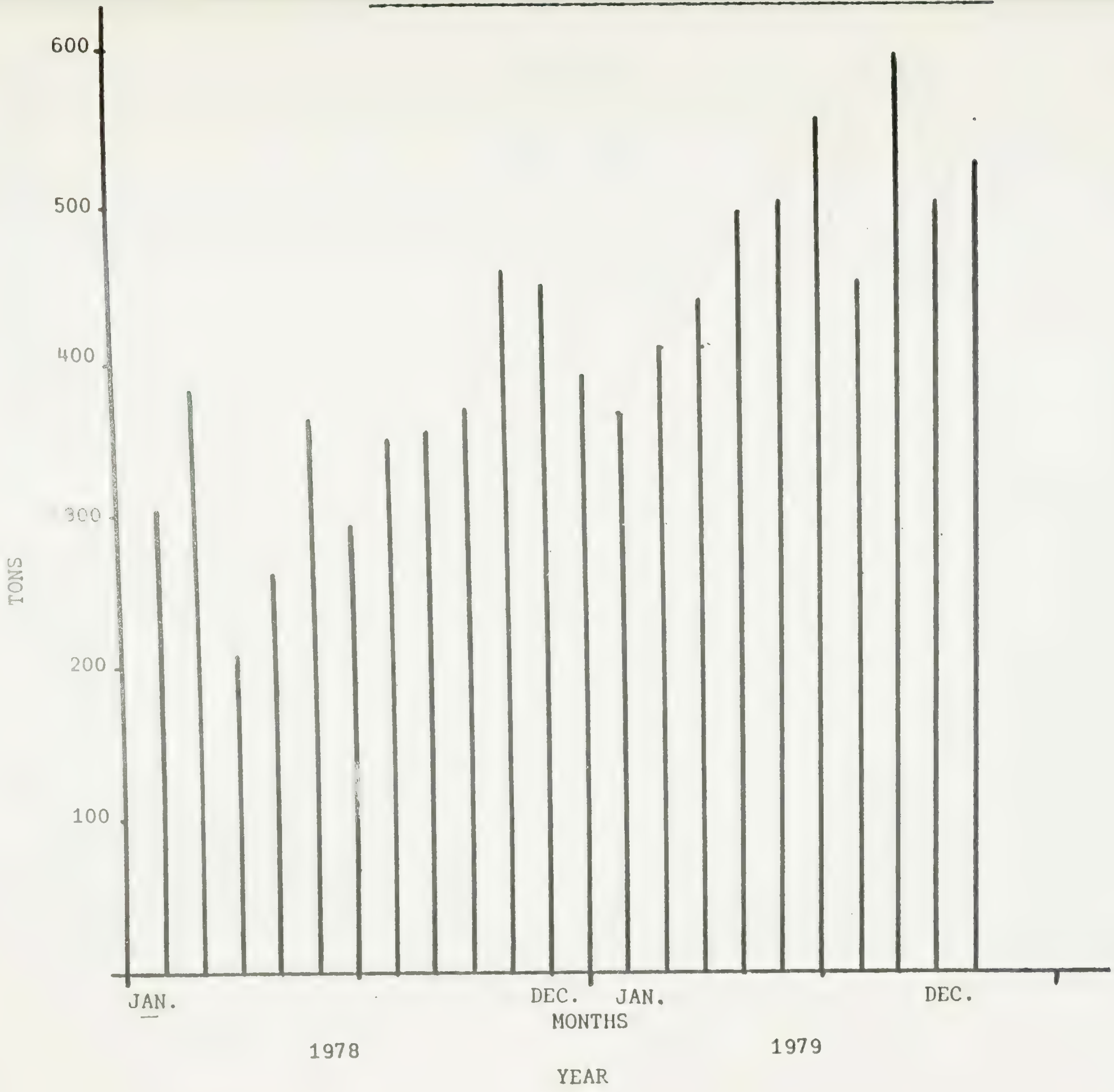


FIGURE 2

DAILY AVERAGE PROCESSING RATE, BY MONTH

1977 - 1979

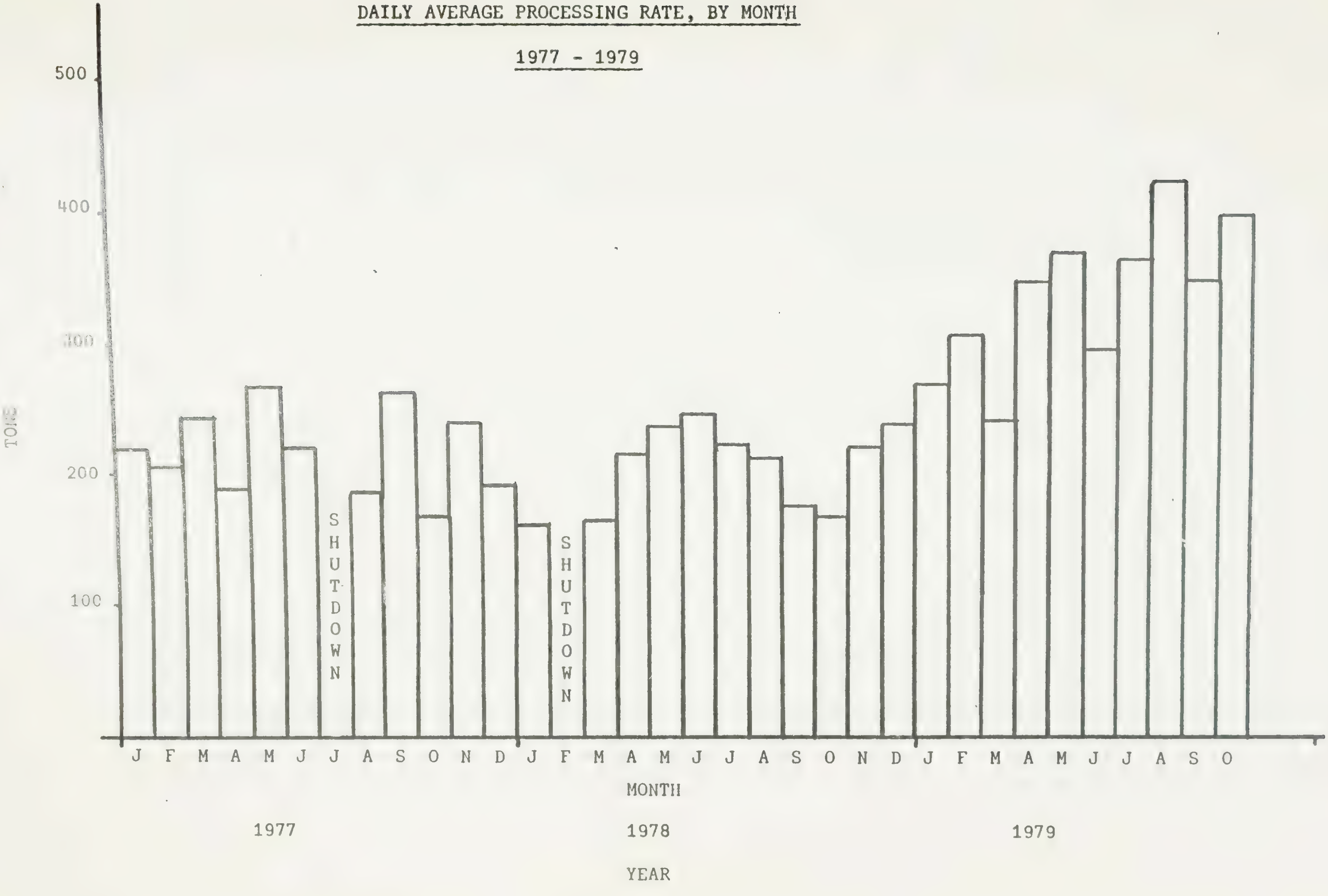


FIGURE 3

ANNUAL S.W.A.R.U. TONNAGES

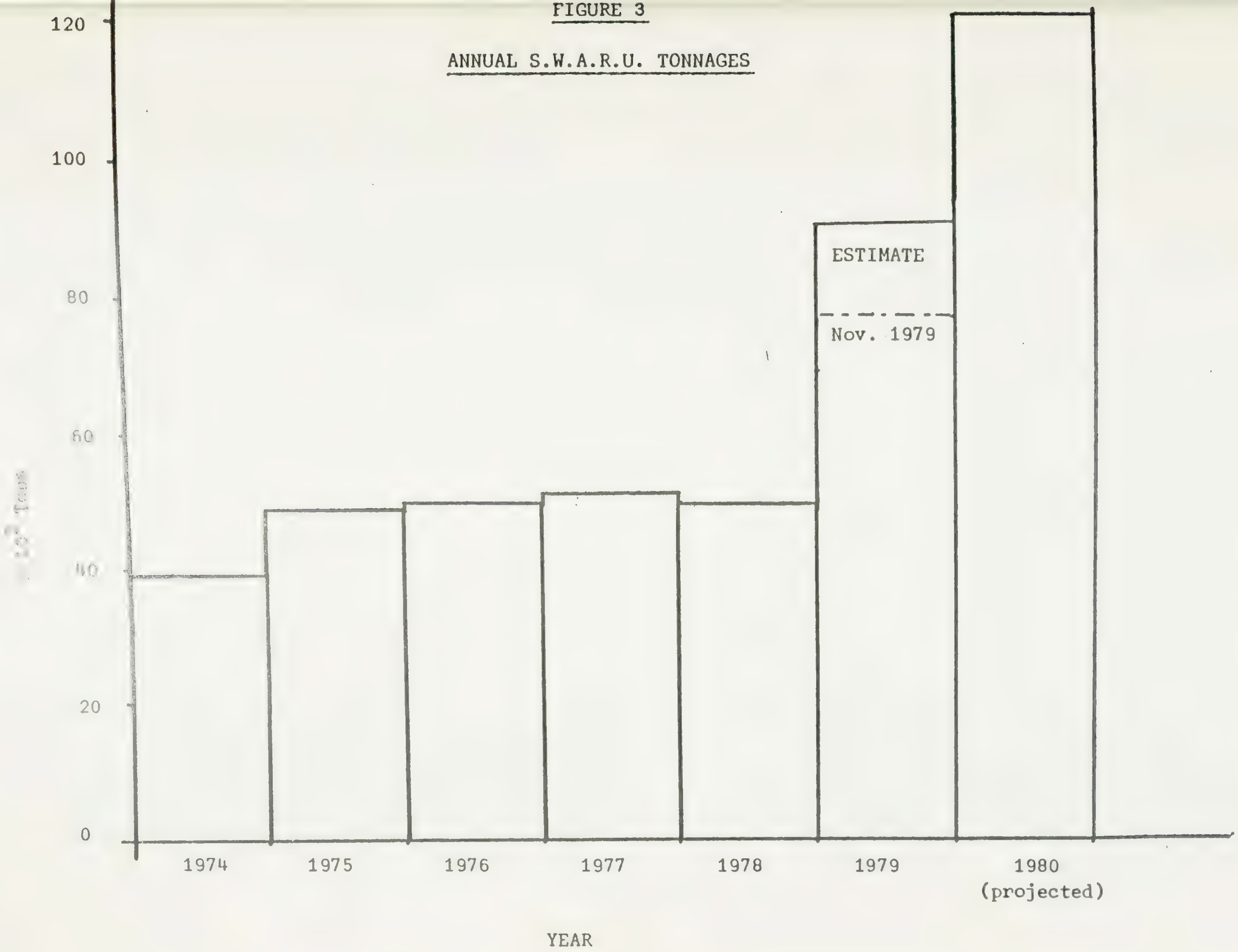
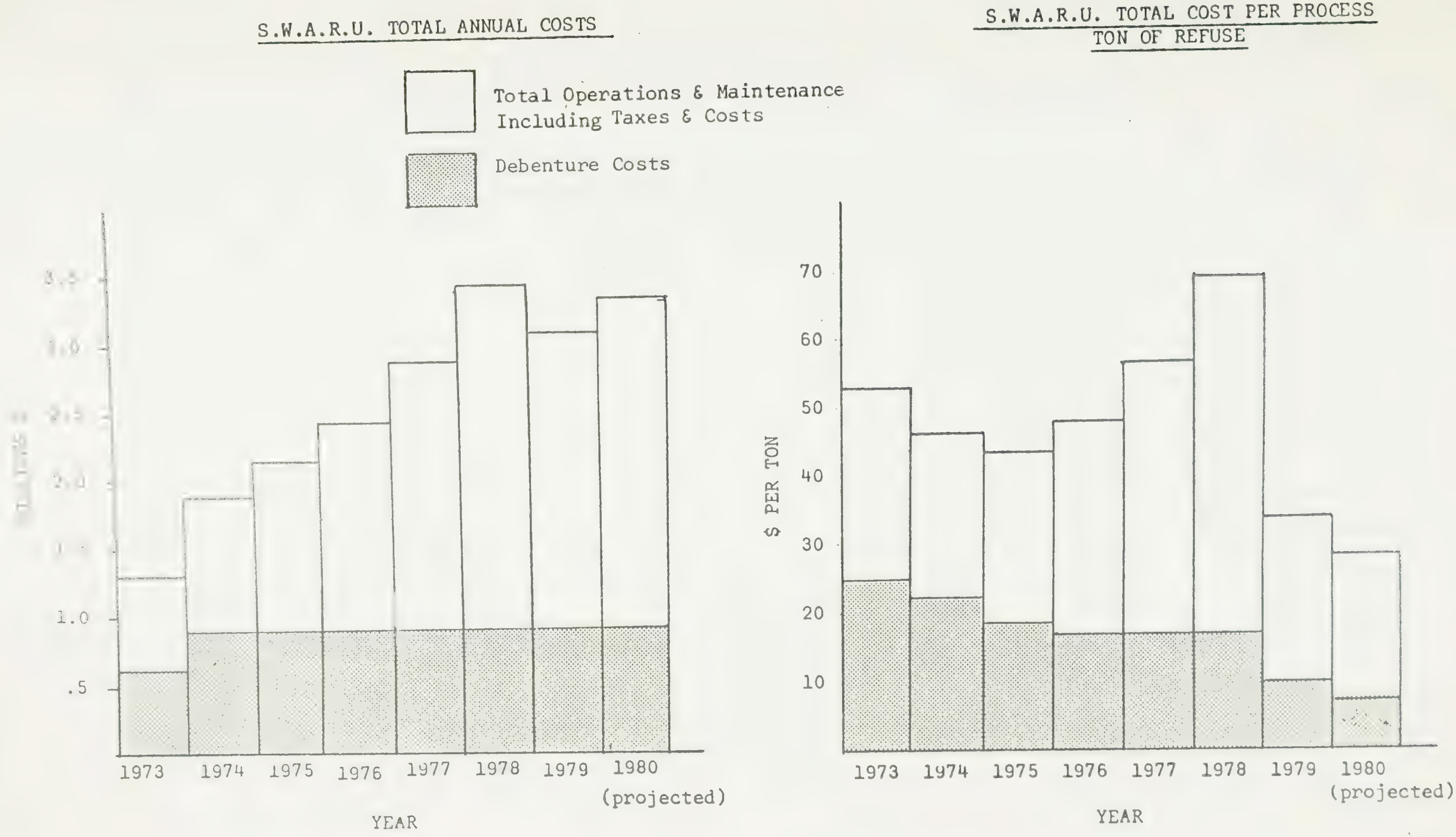


FIGURE 4



S.W.A.R.U. TOTAL ANNUAL COSTS

S.W.A.R.U. TOTAL COST PER PROCESS TON OF REFUSE

"SWARU - BLUEPRINT FOR THE FUTURE"

Presentation to: ENERGY FROM WASTE CONFERENCE
November 21, 1979

By: Joseph W. Kennedy
Tricil Limited

As described by Romeo, the Region of Hamilton-Wentworth's waste management program is a major undertaking and a sophisticated approach for solving one of the most difficult and complicated problems facing most municipalities today. The system being implemented for the Region by Tricil Limited is the first step to eliminate a waste disposal problem and to create an opportunity for resource recovery.

A key component of the program is the modification and operation of the SWARU. This is a waste to energy plant which is the first of it's kind in the world to burn 100% prepared refuse by a semi-suspension process. At the SWARU waste is coarsely pulverized to a nominal size of 4" - 6". The ferrous metal is removed before the pulverized refuse fuel is fed into spreader stoker boilers through air-swept feeders. The waste is fired as it drops toward the grate and burning is completed on the grate to produce steam.

The semi-suspension burning system, itself, is not unique, it has been used successfully for decades to recover energy from wood waste, bark, bagasse, coffee residue and many other waste products. The SWARU employs similar technology to burn municipal solid waste.

Under the terms of our Full Service Contract with the Region, Tricil is committed to upgrading the SWARU and to increase throughput to at least 120,000 tons per year. The contracted operating price to Tricil remains the same for a throughput of 120,000 to 150,000 tons per year. If the

throughput exceeds 150,000 tons per year, Tricil is awarded a bonus, and alternatively if throughput falls short of 120,000 tons per year Tricil suffers a financial penalty. These financial and performance guarantees were made by Tricil without increasing the operating cost of the SWARU to the municipality.

To meet our objective of upgrading the plant to perform as a safe, reliable disposal unit operating on a continuous basis, both operating changes and technical improvements were made. The operation of the plant by private industry has had a pronounced positive effect on the performance of the plant and with total expenditure of about $1.4 million on plant improvements, Tricil converted the plant to successful operation within eighteen months. As the owner of the plant, the Region was responsible to make certain repairs that amounted to about $600,000 of the total expenditure.

To carry out the upgrading program, 58 projects were completed. These projects were divided into five categories:

1. To improve the plant environment to make the plant a better place in which to work.
2. To improve all equipment to the standard required to implement an engineered maintenance program.
3. To improve refuse and ash flow through the process to prevent jamming, bridging or plugging.
4. To improve combustion to upgrade the quality of ash and to reduce emissions.
5. To improve the general effectiveness of the plant to reduce labour and to increase productivity.

As a result of the improved flow through the plant, Tricil is meeting its contractual requirements and is processing up to 580 tons of refuse per day. The plant operates 24 hours per day, 5 days per week with a total plant staff of 34.

More improvements could be made to SWARU, however, because of the high cost of modifications, we have chosen to operate around some of the inherent limitations of the plant.

The plant is located in an industrial park on the east edge of the City of Hamilton. A picture of the plant is appended. Residential housing and apartment buildings are located about one-half mile from the plant.

A schematic flow diagram illustrating the simplicity of the process is appended. A description of the process and some of the improvements made by Tricil follows:

Weighed refuse collection vehicles discharge their loads into the pit or onto the receiving floor. We limit the waste in the pit to about 150 tons so that the waste can be reliably reclaimed from the pit and fed at a relatively uniform rate to the pulverizers. The function of the pit has been changed to that of a large feeder. As waste is required, it is pushed from the floor into the pit. At the plant we received packer truck wastes and selected commercial and industrial wastes.

Four parallel steel pan conveyors bring the waste out of the pit and feed four pulverizers. Any troublesome material is hand-picked from the pan conveyors. It is also feasible to recover corrugated paper before pulverization.

The pulverizers are the verticle shaft type and each is driven by a 200 H.P. motor. The chutes to the pulverizers have been rebuilt by Tricil just as all transfer points in the plant were rebuilt to eliminate plugging. Refuse contains everything from the daily newspaper to the kitchen sink and it's characteristics can vary season to season and even day to day. Thus, the conveyors, chutes and equipment must be capable of handling such variations.

The pulverized refuse fuel is now easily transported by belt conveyors which are reliable and provide process flexibility to accomodate any future processing options. The conveyors have been re-arranged to completely by-pass the 400 ton capacity pulverized refuse storage tank. Thus, the pulverized refuse is fed directly from the pulverizers into the two boilers.

A new system to control refuse feed to the boilers was developed by Tricil. Additional control panels were installed and all of the controls for the entire plant were consolidated in the boiler control room.

On route to the boilers, the pulverized refuse fuel passes under a three stage magnetic separator which removes the ferrous metal. To retain its highest economic value, ferrous metal is recovered prior to combustion to avoid oxidation and alloying. Approximately 5% of the waste received is being recovered as ferrous metal. The metal is loaded into 40 yard containers and is sold to Metal Recovery Industries who remove the tin and bale and sell the remainder for scrap. Currently, we are receiving $30/ton for our recovered metal.

The pulverized refuse fuel is uniformly distributed across the boiler through air-swept feeders. The waste is dried and fired as it drops toward the grate. A diagram of the cross-section of the spreader stoker boiler is appended. It has a waterwall furnace and because of the semi-suspension burning process no refractory whatsoever is required. Complete combustion with minimum excess air requirement and uniform high furnace temperatures is achieved by suspension firing with on-grate burning. The grate travels to the front of the boiler against the direction of waste feed. The grate is relatively small and simple in design.

Just as coal requires pulverization and oil requires atomization, garbage, especially, requires some preparation to achieve efficient combustion.

The refuse burns down to a depth of 4" - 6" of ash on the grate. The appended picture shows the ash being discharged from the front of the grate into the ash tank. Suspension firing enables relatively low grate temperatures and glass remains unmelted so clinkers and slag are not formed.

Tricil replaced the manual dry ash removal systems with continuous wet systems. The new systems reduced labour requirements and improved combustion by eliminating the infiltration of air into the boilers when the ash hoppers were being manually emptied.

A high quality, sterile granular ash (see appended picture) representing about 4% by volume and 16% - 20% by weight of the waste received is produced from the combustion process. This ash can be readily processed to separate non-ferrous metals and various types of aggregate. The New York State EPA, in conjunction with the City of Albany, have completed an ash constituent study at the SWARU. An ash processing pilot plant was constructed and separations were achieved by milling and screening operations.

The flue gases are cleaned by 2-stage electrostatic precipitators. The installation of continuous flue gas analyzers aided in improving the operation of the boilers, thus, dramatically reducing fly ash carryover and the loading on the precipitators. To comply with environmental regulations, we must operate with our stack gases reading less than 20% opacity.

About 25% of the steam generated is used in the plant for steam turbine drives, the remainder is condensed by air cooled condensers and the condensate returned to the deaerator. The turbines are actually designed to be inefficient requiring high steam consumption. If energy could be sold, the turbines would be replaced with more efficient ones.

Up to 150,000 lbs./hour of steam is being generated and we are now concentrating our efforts to utilize this steam. Assuming 120,000 lbs./hour of steam is available for sale, the potential energy credit at $5/1,000 lbs. steam is $600/hour or $24/ton of refuse burned. The gross cost to the Region for processing refuse through the SWARU is $25 - $30/ton including debt charges. Thus, if energy from waste at the SWARU was fully utilized, a relatively low disposal fee would be possible.

Two energy projects are being pursued.

1. The sale of up to 20,000 lbs. steam/hour to General Concrete Ltd. which is located about one-half mile from the SWARU.

2. The installation of a turbine generator to produce at least 3.5 Megawatts of electricity for sale into the grid. The rate being offered by Ontario Hydro for the electricity is equivalent to the incremental fuel cost of coal. Such a rate will not even support the capital investment of the installation of the turbine generator at the SWARU. If power generation from renewable energy sources is to take place in Ontario, a dramatic change to a more equitable rate structure is required. Ontario's future energy options should maximize the use of those energy sources which are available in the province. Therefore, since Ontario must import all of it's coal, oil and gas, development of nuclear power and the use of renewable energy sources such as biomass which includes garbage should be encouraged.

To give you some perspective of the potential energy value of municipal solid waste, it is interesting to note that a pound of garbage contains 2½ times the energy value of a pound of tar sands. If energy was to be produced from the garbage generated in the 25 largest urban areas in Canada, the equivalent of 300 million gallons of oil per year could be saved.

Several countries in Europe actually utilize the energy value in their solid waste, for example, in Denmark over 65% of the refuse is burned to produce useable energy.

The capital investment required for a garbage burning plant is slightly higher than the investment required for a coal burning plant of similar capacity. However, the total cost of steam or electricity from an energy from waste plant is much less than the cost of equivalent energy from a new coal burning plant or the cost of new energy sources such as nuclear, James Bay or the tar sands.

Garbage is an unique resource. What other resource contains 8% metals, and is a relatively clean fuel with little or no sulphur? Garbage is already being collected and it is produced in abundance in urban areas exactly where raw materials and energy are most needed. At the moment this potential energy source is being buried in the ground at great cost both financially and environmentally.

Energy from garbage is not a panacea for our energy problems and likewise energy from garbage is not a panacea for our waste disposal problems. Because of the heterogeneity and unpredictable nature of garbage, it is a difficult material to handle and its limitations must be respected. However, if prudently implemented, the waste to energy approach can contribute to reducing both our energy and waste disposal problems.

When considering the use of technical processes to handle waste materials, a developing trend in North America is to involve specialized private sector waste management companies to supply the technical systems and to operate the systems under long term service contracts. In this manner, the purchaser of the service is guaranteed that the supplied technology is practical and will function as described by the supplier over a long period of time. Companies like Tricil have alot to offer in the implementation of these technologies. We have accumulated valuable operating experience with waste processing plants and we have also developed our own refinements to technical approaches.

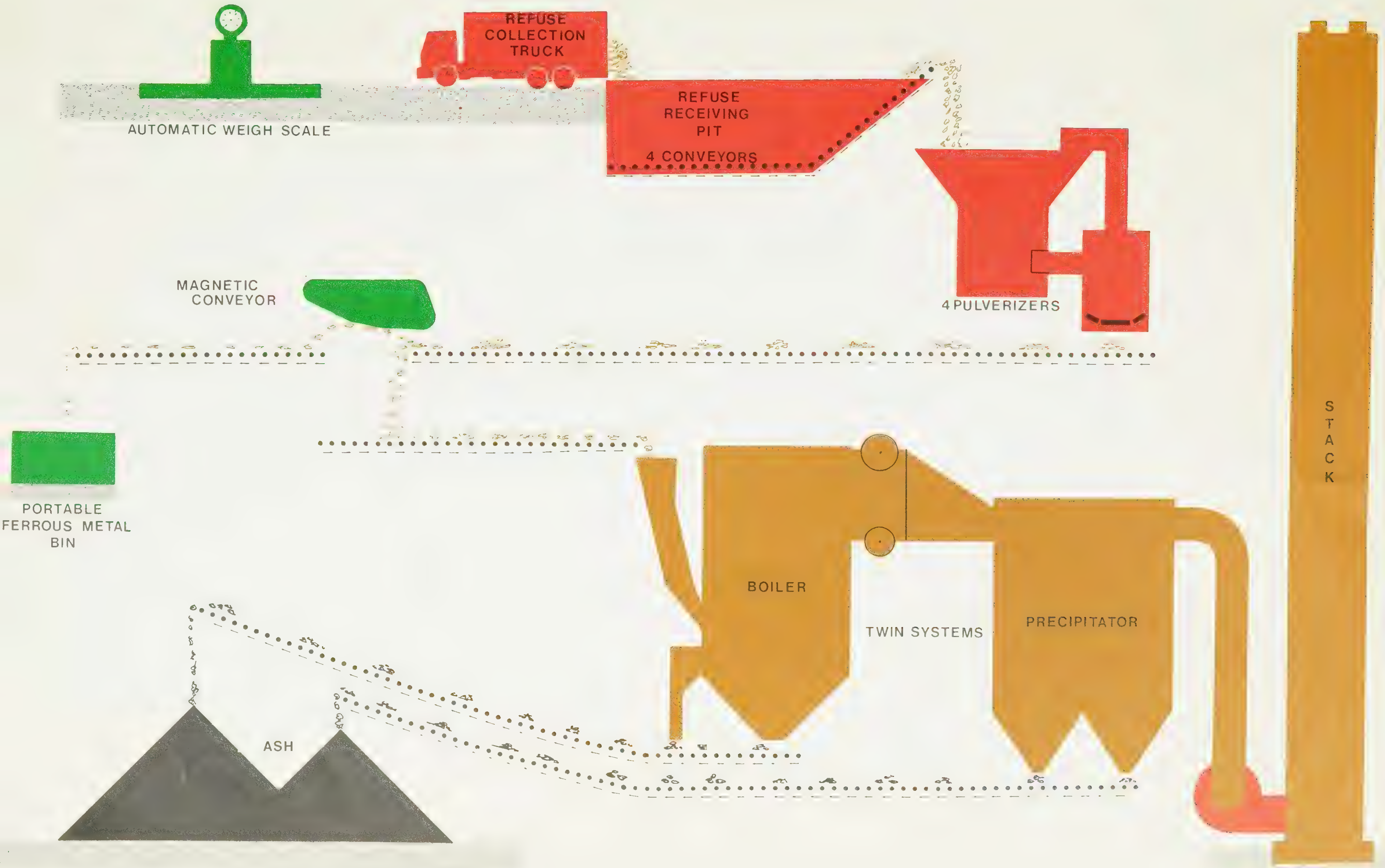
In conclusion, it has been a pleasure working with the Region on the "SWARU project." The semi-suspension burning system of SWARU is ideally suited for material and energy reclamation from municipal solid waste. The technology is being successfully demonstrated at the Hamilton Plant. Simple waste processing and high combustion efficiency are achieved with known equipment to make this technology one of the most reliable and cost effective systems available.

In addressing previous comments expressing concern about continuing to produce waste in order to supply waste to energy plants, it is essential that these plants are flexible in design. If it becomes possible and more economical to recover and recycle components of garbage instead of burning these components for their fuel value, the waste to energy plants must be capable of burning some other material such as wood or coal to produce the energy required. The semi-suspension burning system allows this flexibility.

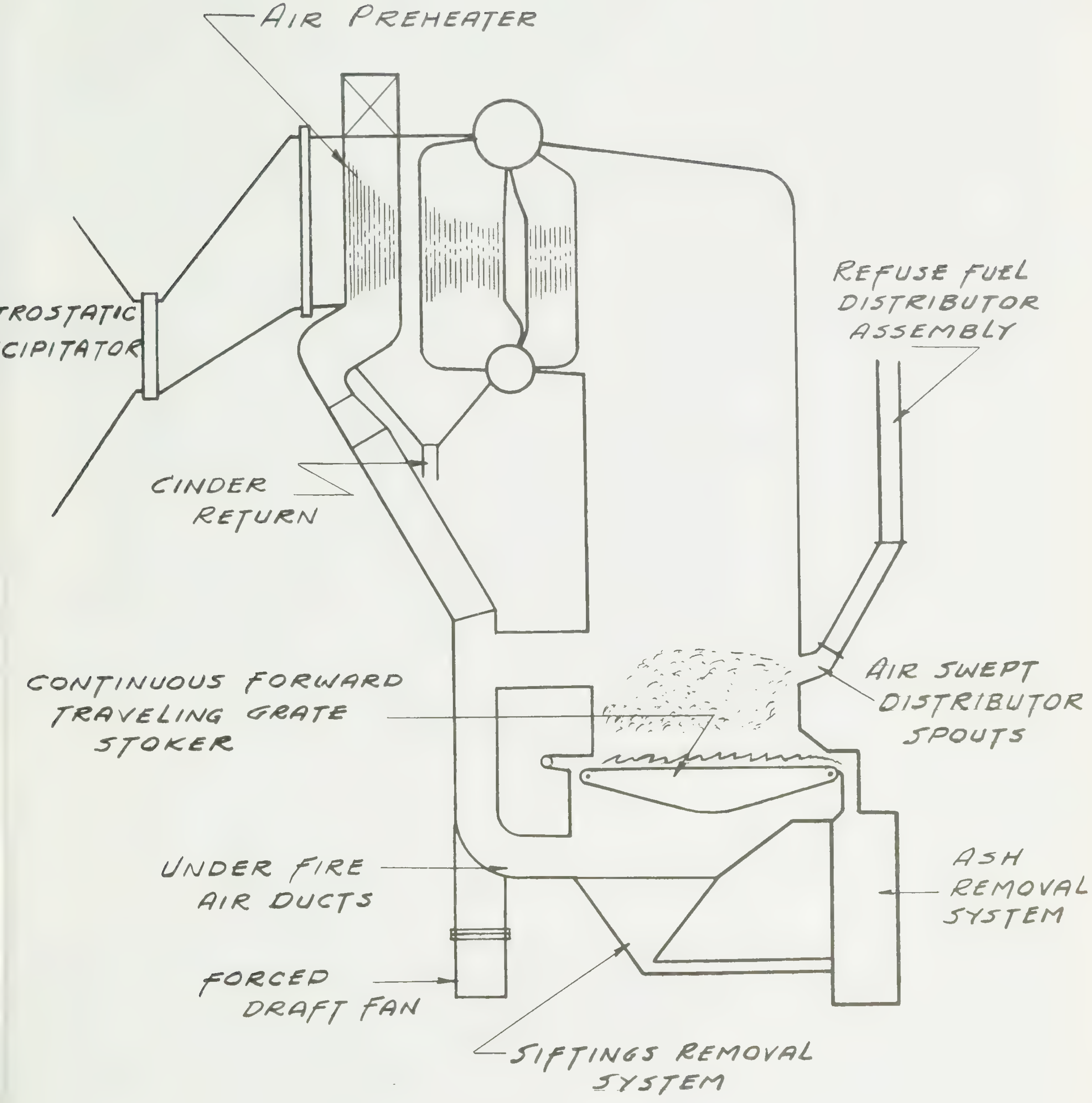
Romeo and I would be pleased to answer any questions which you may have concerning the Region of Hamilton-Wentworth program.

View of the Solid Waste Recovery Unit (SWARU) in operation at Hamilton, Ontario.

HAMILTON PLANT
PROCESS FLOW DIAGRAM



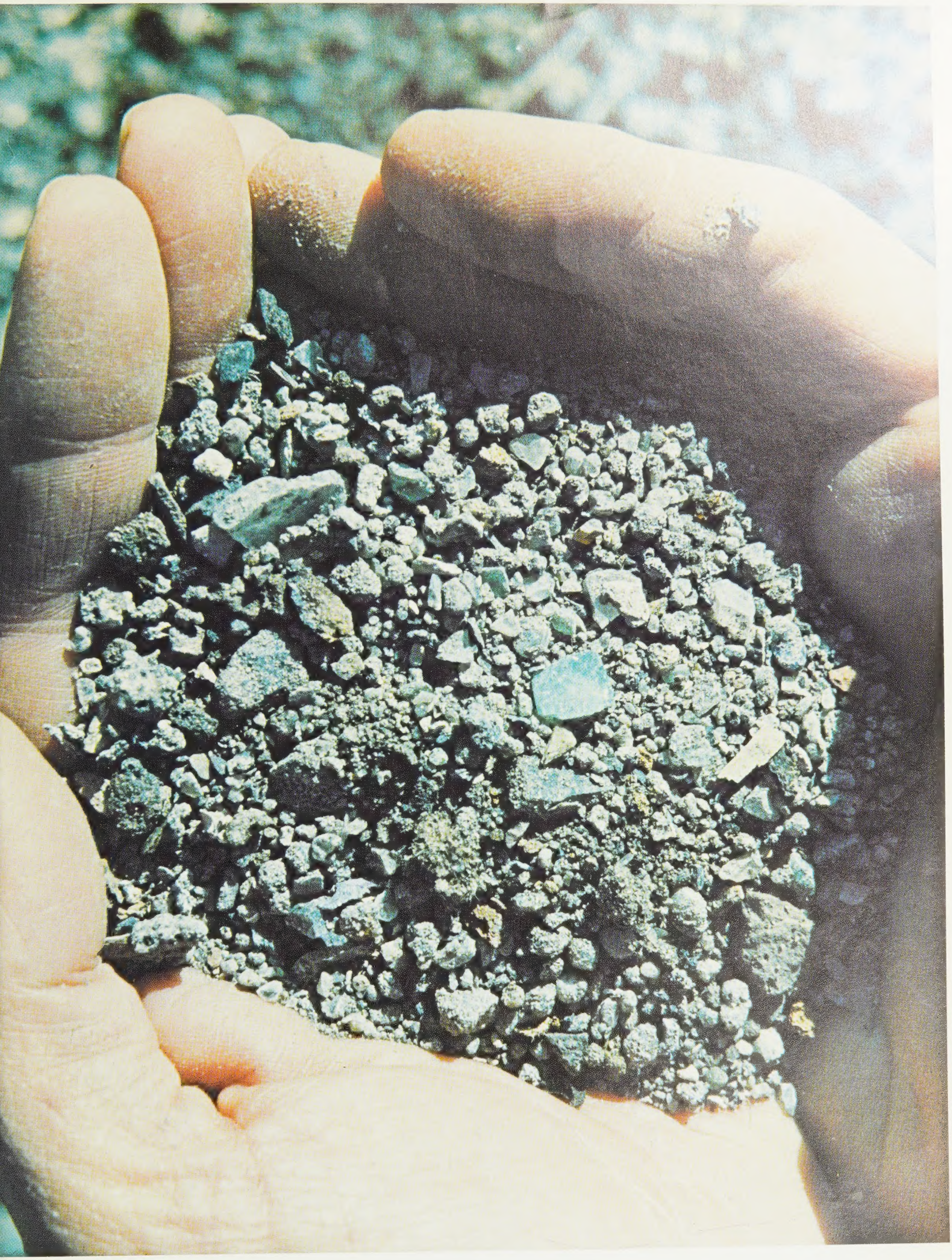
REFUSE COLLECTION TRUCK
AUTOMATIC WEIGH SCALE
REFUSE RECEIVING PIT
4 CONVEYORS
4 PULVERIZERS
MAGNETIC CONVEYOR
PORTABLE FERROUS METAL BIN
BOILER
TWIN SYSTEMS
PRECIPITATOR
STACK
ASH


AIR PREHEATER
TROSTATIC
CIPITATOR
CINDER
RETURN
REFUSE FUEL
DISTRIBUTOR
ASSEMBLY
CONTINUOUS FORWARD
TRAVELING GRATE
STOKER
AIR SWEPT
DISTRIBUTOR
SPOUTS
UNDER FIRE
AIR DUCTS
ASH
REMOVAL
SYSTEM
FORCED
DRAFT FAN
SIFTINGS REMOVAL
SYSTEM

CROSS SECTION

SPREADER STOKER BOILER

Combustion efficiency is the key to satisfactory environmental emissions and full energy recovery. Suspension burning provides the highest combustion efficiency.



Clean ash, containing only inerts, demonstrates good combustion, and is a useful commodity. (note unmelted glass)

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